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VII.—*A Descriptive List of the* Uredineæ *occurring in the Neighbourhood of Simla (Western Himalayas).* Pt. III.—*By* A. Barclay, M. B., *Bengal Medical Service.*

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(With Plates III.—VI.)

In this third instalment of a descriptive list of the *Uredineæ* of Simla (in continuation of the second part in this Journal, Vol. LVIII, Pt. II, 1889), I complete a description of all the species known to me up to the present time. The present part includes descriptions of 6 species of *Uromyces*, 4 of *Phragmidium*, 3 of *Melampsora*, 3 of *Coleosporium*, 1 of *Gymnosporangium*, 2 of *Chrysomyxa*, 2 of *Cæoma*, and 6 of isolated *Uredo* forms. I have also added descriptions of four *Aecidial* forms, which should have been included in Part I of this List, and seven species of *Puccinia*, which should have found a place in Part II.

I must here express my obligations to Dr. George Watt, C. I. E., for his kind and ever ready help in determining the species of many hosts.

UROMYCES, Link.

There are remarkably few of these in this region, only six species so far as I am at present aware, and all but one on the higher phaner-

ogamous plants, the exceptional one being on a grass. The most remarkable of these is *U. Cunninghamianus*, presenting extremely anomalous characters. Another interesting species is that on *Strobilanthes*, as this host also bears an *Aecidium* which is, however, in no way related to the teleutosporic fungus.

a. HEMIUROMYCES, Schröter.

1. Uromyces Vossiæ, nov. sp.

On *Vossia speciosa*, Benth.

This grass is sometimes largely attacked by a species of *Uromyces*. In August the leaves may be seen in commencing attack with the formation of brown uredo pustules on the under leaf surface. These pustules are small, oval or linear, and isolated.

The *uredospores* are brownish, with sometimes a tinge of orange red, very deciduous, falling off without any portion of stalk adhering. The cell wall is uniform in thickness, and presents three or four pores, easily seen by treatment with sulphuric acid. They measure on an average $24 \times 19{\cdot}2\mu$, varying from 25×22 to $23 \times 17\mu$. The epispore is finely warty. They germinate in water in the usual way, throwing out a simple germ tube (fig. 1, Pl. I.)

Late in the year *teleutospore* pustules are formed. These are well raised oval or linear dark brown sori, also hypophyllous. The spores are very readily detached, coming off with a small portion of stalk adhering. They do not germinate on maturing, but only after a period of rest. These are thicker walled than the uredospores, and are especially thickened at the apex. They measure from 24×21 to $29 \times 22\mu$, when fresh and examined in water. In spring they germinate very readily in water (fig. 2, Pl. I.)

b. UROMYCOPSIS, Schröter.

2. Uromyces Cunninghamianus, Barclay.

On *Jasminum grandiflorum*, L.

For a complete description of this parasite I must refer the reader to a paper on its life history read at the Linnean Society on the 18th December, 1889. The diagnostic characters of the species are as follows:

Towards the end of August the leaves and smaller stems of the host are largely attacked in the aecidial stage, and these are then much hypertrophied. The peridia burst in a stellate fashion, allowing the orange red aecidiospores to fall out. When these spores have been shed, teleutospores are formed within the old peridia. These teleutospores are

adherent, and remain in a quiescent state until the following year, when they germinate and reproduce aecidia on the newly developed leaves. Experimental evidence, which will be found detailed in the above-mentioned paper, fully confirmed the autœcious nature of the fungus.

The *aecidiospores* are round or oval pale yellow bodies, and measure on an average 16μ in diam. They are tuberculated on the outer surface. Their mode of germination is quite peculiar. A germ tube is emitted, about 35μ in length, which then divides into two by a transverse septum, and each part forms a long narrow sterigma, which, however, forms no sporidium, but directly penetrates the host to form another mycelium, bearing aecidiospores at first (but no spermogonia) and teleutospores later.

The *peridium* is formed of a single layer of cells about $26 \times 19\mu$ in size.

The *spermogonia* accompany the first crop of aecidia: they are not numerous, and measure about 145μ in depth and width. They have a tuft of protruding paraphyses.

The *teleutospores* are brown single-celled bodies, thickened at the free end, firmly adherent to their beds, becoming detached with a portion of stalk adhering. They measure $36 \times 20\mu$ on an average. They germinate after a winter's rest in the usual way, each promycelium forming three sporidia as a rule, but sometimes four.

The *sporidium* is oval, and measures $12 \times 8\mu$ to $14 \times 10\mu$. Secondary sporidia are abundantly formed, often before the primary one has become detached.

3. Uromyces Valerianæ, Schum.

On *Valeriana Wallichii*, D. C.

For a description of this species see the Journal of this Society, Vol. LVI, Part II, No. 3, 1887, page 352.

Dr. P. Dietel (Leipzig) to whom I sent specimens of this fungus thinks it is a new species.

c. LEPTUROMYCES, Schröter.

4. Uromyces Solidaginis, Niessl.

On *Solidago Virgaurea*, L.

This host may be found in some localities largely attacked in August and September. Attention is drawn to the fungus by the circular discoloured patches produced, mostly on the radical leaves, but sometimes also on higher leaves. An attacked plant, however, does not usually form a flowering stalk. These discoloured patches (pale yellow)

when first coming to notice are about 5 m.m. in diameter, and then bear but a few spore pustules on the lower surface; but as they grow older they enlarge, become paler, and therefore more conspicuous, bear very numerous minute pustules, still mostly on the lower surface, but a few isolated ones on the upper surface also. An old patch may attain a diameter of 1 c.m. A single leaf may bear from 1 to 30 patches and even more. The spore pustules are minute brown sori, with the spores fairly adherent. If these spores be examined they are found to be teleutospores; there are no uredospores. A careful search over both the upper and lower surfaces of patches disclosed no spermogonia, even on the youngest.

Each spore is pale brown, with a small portion of stalk adhering, much thickened at the apex, and with a clearly defined nucleolar space. Through the apical thickening a germ pore may be seen. The free end of the spore is usually rounded, but is sometimes conical, and may even be pointed. The surface of the spore is smooth. The fresh spores examined in water measure 27 to 30 by 17μ, the apical thickening being 10μ. These spores germinate at once, if placed in water in a watch glass, in the usual way, producing four sporidia on long narrow sterigmata. The sporidia are round to oval, measuring from 10μ in diameter to 12 × 10μ. These also germinate readily. If the spores are placed in a hanging drop of water, with very little air, the peculiar germination described by Kienitz-Gerloff as occurring in *Gymnosporangium* spores takes place. That is to say, the end of the promycelium breaks up into three or four cells, which become detached, and which further germinate by throwing out a germ tube. I have already described this in a paper on the life history of *Cæoma Smilacis*, the teleutospores of which exhibit the same phenomenon.* These detached cells, which apparently act as sporidia, measure from 8 × 8 to 18 × 9μ, or on an average of several measurements 14·0 × 8·1μ.

d. MICRUROMYCES, Schröter.

5. Uromyces Strobilanthis, nov. sp.

On *Strobilanthes Dalhousianus*, Clarke.

In autumn the leaves of this host bear numerous pustules on the lower surface. Whilst it is common in some years it is rare in others. I could not, for instance, find any in 1889. The spores are very firmly adherent to their beds and when scraped off retain a portion of stalk. They are more or less elongated bodies, reddish brown by transmitted

* Scientific Memoirs by Medical officers of the Army of India, Part IV, 1889.

light, with the free end considerably thickened. When well moistened the spores measure from 26 × 16 to 34 × 14μ, or on an average of several measurements 30·4 × 14·6μ. The length of the stalk adherent is usually about 40μ. They germinate only after a period of winter rest; at least they do not germinate in autumn; but I have not observed their germination in spring.

This teleutospore has no genetic relationship with the *Aecidium* borne by the same host.*

6. Uromyces McIntirianus, nov. sp.

On *Hemigraphis latebrosa*, Nees.

This fungus was collected by Mr. A. L. McIntire, of the Forest Department, in the Simla region; but I have not myself found it. The pustules are circular, minute, coalescing, and mostly hypophyllous. The spores are brown, coming off with a long piece of stalk attached. They are oval, contracting slightly towards the stalk, slightly thickened at the apex which is rounded, and quite smooth on the surface. Among them are a few two-celled spores (*Puccinia*) and some fewer single celled but much larger spores, possibly though not probably of the nature of uredo-spores. The teleutospores vary considerably in size, 33 — 24 × 26 — 18μ, when just moistened. The few two celled spores measured 38 — 32 × 24 — 16μ. These spores are also brown, rounded at both ends, smooth, and with little or no constriction at the septum. The large single-celled spores measured 36 — 34 × 27 — 22μ. None of these spores germinated when placed in water; but they had been preserved some months in botanical drying paper.

Remarks.—As far as I am able to determine this is a new species and I have named it after the collector.

PHRAGMIDIUM, Link.

a. EUPHRAGMIDIUM, Schröter.

1. Phragmidium subcorticium, Schrank.

On *Rosa moschata*, Mill.

I found this host attacked by a species of *Phragmidium* early in September. The leaves bore at this time both yellow uredo- and black teleutospore pustules, the latter readily distinguishable from the species on *Rubus* by their smaller size, and by their irregular and general distribution over the lower leaf surface, instead of being in special cir-

* Scientific Memoirs by Medical officers of the Army of India, Part II, 1886.

cular patches on the leaves. On examining the yellow pustules they were found to contain numerous uredospores, with some immature looking yellow teleutospores, while the black pustules contained mostly dark brown teleutospores. These spores were put at once into water, and while the uredospores germinated in the usual way no teleutospore did so.

The *uredospores* are angular orange red bodies, with an epispore beset with numerous warts (almost spines) and punctured by 7 to 9 germ pores. They measure about 26 to 30μ in diameter. Only one germ tube is emitted by each spore.

The *teleutospores* are readily distinguished from those on *Rubus* by their pointed or mucronate ends. In young pustules some teleutospores are orange yellow, though most are dark brown. They are also more divided, each containing usually 7 or 8 cells, but sometimes even ten. They measure about 100 × 33μ (an unusually long spore with ten compartments measured 126 × 33μ). The spores are covered with coarse warts. Another peculiarity consists in a very well marked bulging in the stalks with a cavity containing yellowish granular matter (fig. 3, Pl. I). These spores germinate only after a period of winter rest. In April I obtained sporidial formation in spores I had kept since the preceding autumn. The sporidia are spherical, bright orange red, and 9·5 to 12·5μ in diameter.

The *aecidial stage* consists in the formation of very bright orange red beds, sometimes of very extensive area. These beds are formed on the leaves and on the smaller stems, and the mycelium bearing them always gives rise to hypertrophy, sometimes very excessive, on the stems. In the latter situation the hypertrophy is due to an excessive enlargement of the parenchyma cells between the hypoderma and the central vascular bundles. This stage is met with throughout the summer months. The aecidiospores are given off in long chains, but there is no peridium of any kind. The margin of beds is, however, fringed with club-shaped paraphyses. In this stage spermogonia are numerous. They are superficial, and frequently coalescing groups of them may be found on the upper leaf surface opposite a bed of spores below. The aecidiospores are pale orange red or yellow oval bodies, measuring on an average 20 × 17μ. The epispore is thick and beset externally with tubercles.

A bush in my garden is frequently attacked with this aecidium-bearing fungus, but curiously enough it never bears teleuto- or uredospores.

Remarks.—This is probably *Phragmidium subcorticium*, but the hyaline point at the free end of the teleutospores is not nearly so long as is given by Schröter and Plowright in their works. I would also

draw attention to the resting property of the teleutospores which is in strong contrast with the immediate germinability of the next species.

b. HEMIPHRAGMIDIUM, Schröter.

2. Phragmidium Rubi, Pers. ?

On *Rubus lasiocarpus*, Smith.

A *Phragmidium* on this host is fairly common. On the 21st February I collected some leaves bearing both yellow uredo-like pustules and black teleutospore pustules on separate green leaves. Both kinds of pustules are hypophyllous, in scattered circular pustules, indicated above by a brownish red discoloration of the leaf, especially marked in the case of teleutospore formation. I put some spores from each kind of pustule into growing cells on the following day; but whilst none of the teleutospores from the black pustules germinated, several of those contained in the yellow pustules did so freely, forming ordinary promycelia, dividing into four parts, each bearing a sporidium at the end of a pointed sterigma (fig. 5, Pl. I). The sporidia are round orange yellow bodies, 8 to 10μ in diameter, the diameter of the promycelial tube being 8μ. These latter teleutospores were among numerous uredospores, and were orange red in colour as contrasted with the deep brown of the former teleutospores, which would not at this time germinate. The orange yellow teleutospores were evidently just formed, and, indeed, but for their ready germinability, would be described as immature spores, the more so as they contain fewer cells than the brown spores, namely, 3 to 5 cells against 5 to 7 in the brown spores. Curiously enough the uredospores, which were in the majority in such pustules did not germinate in the cultivations in which the young teleutospores did.

The *uredospores* are round pale orange yellow bodies, with numerous club-shaped paraphyses among them. They are tuberculated on the surface, and measure about 21μ, in diameter. I never succeeded in observing their germination (fig. 6, Pl. I).

Later in the year, from July to December, fresh crops of black teleutospore pustules are produced, without any uredospores. Some of these later teleutospores, which are dark brown and many-celled (on an average six-celled), I put into water on the 10th September, and now they germinated very freely, producing immense numbers of sporidia (four to each promycelium), round or pyriform in shape, orange yellow in colour, and 10 to 12μ in diameter. These brown teleutospores measure on an average 100·8 × 37μ; but of course they vary consider-

ably, especially in length. The free end of the spore is rounded, with occasionally a minute knob. The surface of the spore is beset with tubercles (fig. 4, Pl. I).

I have never seen any aecidial form of this species.

I may add that I collected some of these teleutospores from green leaves in the middle of December, and placing them in water found that they germinated very freely, even so late in the year as that.

Dr. P. Dietel is inclined to think this is a new species as it differs from *Phr. Rubi* in having thick stalks and in frequently wanting an apical cone. He thinks it comes near the Australian *Phr. Barnardi*, Plow et Winter though the latter has lighter coloured spores and forms small punctiform pustules.

c. PHRAGMIDIOPSIS, Schröter.

3. Phragmidium quinqueloculare, nov. sp.

On *Rubus biflorus*, Ham.

In April, the stems bear orange yellow pustules, the leaves very rarely. These are probably aecidia. The spores are brilliantly orange red, bluntly angular with slight thickenings at the angles, and densely beset with warts. The fresh spores measure 24 — 20μ. in diameter. The margins of the pustules are surrounded by club-shaped paraphyses. On applying sulphuric acid (with a view to determining the existence of germ pores, in which I was unsuccessful) the spores first turn deep blue and then later pale blue. The spores germinate readily in water throwing out exceedingly long slender unbranched tubes.

On old dead leaves I found numerous minute, circular, discrete, black teleutosporic pustules, very unlike those of *Phr. Rubi* (above described) to the naked eye. The teleutospores are mostly brown, but some are orange red, and are very regularly divided into 4 to 5 cells, each well rounded, with a minute, colourless rostrum at the free end. The stalk is slightly bulged, and contains a cavity. They measure 80 — 64 × 22 — 20μ. The length of each cell is about 12 — 13μ. I could not determine the number of germ pores to each cell.

After a winter rest the teleutospores germinate freely. The procelia before forming sporidia are filled with orange red matter. The sporidia are spherical and orange red, measuring 12μ in diameter, and are borne on fairly long narrow and pointed sterigmata.

Remarks.—I do not think this fungus is identical with *Phr. Rubi* Pers, *Phr. violaceum* or *Phr. Rubi-Idaei*, Pers. I have regarded it as a new species provisionally; but it is difficult to be certain about this.

d. PHRAGMIDIUM (INCOMPLETE.)

4. PHRAGMIDIUM INCOMPLETUM, nov. sp.

On *Rubus paniculatus*, Smith.

In March I found the leaves of this host bearing the uredospores (aecidiospores ?) of some species of *Phragmidium* probably, which I have not been able to determine, never having seen the teleutospores. It was found in a deep valley near Simla. The nerves of the leaves were mostly attacked, and in such places they were distinctly hypertrophied : a few pustules were also found, however, upon the blade proper. The pustules were entirely hypophyllous, but their places were indicated on the upper surfaces of the leaves by reddish brown spots of discolouration. The pustules were light yellow and small.

The spores are yellow, round to oval, beset with prominent spines, and measured when fresh $34 - 30 \times 25 - 23\mu$. There are no paraphyses. They germinated readily in water, throwing out single long unbranched straight tubes, mostly aerial.

Remarks.—In this incomplete stage it is impossible to identify it with any known species.

MELAMPSORA AND COLEOSPORIUM.

I have found considerable difficulty in separating certain Uredines into *Melampsora* and *Coleosporium*, mainly because I have not been able to observe the germination of the teleutospores sufficiently accurately. Apart from this, however, the morphological characters of each group are sufficiently definitely set forth in Winter's work* to enable one to separate them with confidence, were these characters maintained in each species. For example, it is stated that in the genus *Melampsora* the teleutospores are single-celled, or vertically divided, rarely horizontally, and that the uredospores are borne singly on basidia ; whilst in the genus *Coleosporium* the teleutospores consist of several, usually four, superimposed cells, and the uredospores are in short chains. But in the case of the Simla forms these characters are not separately maintained, for whilst in some species the teleutospore forms conform with the description of *Melampsora* spores the related uredospore forms resemble *Coleosporium* forms. This is the case, for example, with the parasites on *Hypericum* and *Leptodermis*. In these species the teleutosporic forms are distinctly of the *Melampsora* type, whilst the uredos being in well defined chains, resemble *Coleosporium*. As the teleutospores are the more important I have considered these forms species of *Melampsora*.

* "Die Pilze Deutschlands," &c.

In only one species, namely, that on a species of *Salix*, do the characters of the teleutospores and uredospores coincide with the descriptions given by Winter. This would appear to show that the distinctive characters of the uredospore formation in the two genera as usually given, are not of generic value. Lastly, I would draw special attention to the formation of spermogonia in one of these fungi, namely, on *Hypericum*. So far as I am aware the existence of this form of fructification has never yet been observed in any other species either of *Melampsora* or of *Coleosporium*.

MELAMPSORA, Castagne.

a. HEMIMELAMPSORA, Schröter.

1. Melampsora Sancti-Johannis, nov. sp.

On *Hypericum cernuum*, Roxb.

This is a very remarkable parasite, causing very noticable abnormalities in the host; for not only are its leaves sometimes covered with conspicuous localised patches of discoloration, but whole shoots are often involved (fig. 3, Pl. II). In the latter case the shoot is, before the formation of teleutospores, of a sickly pale yellowish green colour; often hypertrophied when quite young; but this hypertrophy is masked later on by arrested growth of the shoot, and the normal shoots of equal age continuing to grow throw the attacked shoots out of comparison. The leaves borne by such attacked shoots are always considerably smaller than healthy ones. The fungus in one form or another is to be met with almost throughout the year upon the living host. It is extremely common in this neighbourhood, and plants are often met with completely eaten up with it. The normal course of the fungus through the year is as follows:

In early spring (March) both the localised leaf patches and wholly involved shoots are abundantly met with; but the latter are always more abundant than the former. In April some uredo pustules are formed on both localised patches and on the leaves of wholly involved shoots; but much oftener on the latter. These pustules are, however, very uncommon, and must be looked for diligently. I have found them only in April. During the time uredo pustules are formed spermogonia also are found on the same leaves. These are mainly epiphyllous, though a few may be found also on the lower surface. The uredo pustules are minute circular pale yellow sori, mostly hypophyllous. After April there is a cessation of activity in the reproduction of the fungus until July. In this interval, however, if from unusual wet weather new shoots are formed by the host, some of them are found

attacked. Under similar circumstances a few localised patches are also found; but as a rule the interval is one during which the fungus is comparatively rare. Early in July, after the commencement of the rains, the host puts forth new shoots abundantly, and many of these are then found to be wholly attacked; localised patches are very rare, and almost entirely absent. The September, towards the end of the rains, localised patches are again formed, and become fairly abundant, though not so abundant as in spring. Lastly, from October to spring the fungus is again rare in both forms; and, indeed, in the depth of winter (December to February) it may be said to be absent.

The localised patches are found on quite healthy leaves. When quite young they are circular, very conspicuous, especially on the upper leaf surface, from their yellowish green colour, and measure about 5 m.m. in diameter. The edge of the patch above is often surrounded by irregular reddish brown spots. The patches in time increase considerably in area. A single leaf may contain from 1 to 8 such patches.

The leaves of wholly involved shoots are generally covered on their under surfaces with irregular beds of a brownish orange to deeply orange colour, forming diffused blotches, which often in time coalesce, and uniformly cover the whole of the lower leaf surface. A few such blotches sometimes occur on the upper surface also; but rarely.

The *uredospores* are given off in short chains, and there are no paraphyses among them (fig. 2, Pl. II). They simply burst through the epidermis, a fray of which may be seen on the margin. The whole depth of the uredo bed is about 0·100 m.m. They are very irregular in size and shape, pale orange or yellowish red in colour, with an epispore finely tuberculated. They measure when fresh and examined in water 25·3 × 21·7μ on an average, varying from 22 × 20 to 30 × 28μ. After lying many hours in water they measure 38 × 30·8μ on an average, varying from 25·2 to 44·1μ in diameter. They germinate in water, but not readily, throwing out a simple germ tube. In transverse sections three to four ripe spores may generally be seen in a row, with as many immature ones below. It is noteworthy that in fully involved leaves from wholly attacked shoots there is no differentiation of the leaf tissue cells into palisade and spongy cells: the former are, however, quite typical in normal leaves (fig. 2, Pl. II).

The *teleutospores* are formed beneath the epidermis, which is gradually lifted and disorganised, laying the spores bare. These beds, when just formed, are seen in transverse sections of leaves to be very slightly elevated above the general epidermis level. The depth of such a bed is about 30μ. When transverse sections of leaves through teleutospore beds are kept in water the spores germinate, throwing out a simple

promycelial tube, measuring 4 to 6μ in diameter, which bears a sporidium 6μ in diameter. The teleutospores are long very narrow cells, very densely packed together side by side (fig. 1, Pl. II); so much so that in section the spores are polygonal. Each spore is about 26μ long and 6 to 8μ broad. The spores are never horizontally divided but are sometimes obliquely divided. Fig. 4, Pl. II represents a surface view of portion of a spore bed. It will be seen how small they are in diameter.

The *spermogonia* are large flat structures, very frequently contiguous to a uredo pustule. They measure from 0·252 to 0·346 m.m. in width, and 0·126 to 0·144 m.m. in depth, and their bases rest upon subepidermal tissue (fig. 2, Pl. II). They appear to have no tuft of paraphyses protruding, at least I saw none in the numerous permanently mounted preparations I made and examined.

Remarks.—This is evidently distinct from *M. Hypericorum* (D. C.) as both the uredo- and the teleutospore beds are large and extremely conspicuous, whilst those of the European species are said to be very inconspicuous and small.

2. Melampsora Leptodermis, nov. sp.

On *Leptodermis lanceolata*, Wall.

Early in August the leaves of this host discover small saffron yellow uredo pustules on the lower surface, with pale yellow spots on the upper surface opposite them. The leaves are generally extensively bespattered with these pustules.

The *uredospores* are given off in chains (fig. 6, Pl. II), and are orange yellow (more yellow than orange), round, or slightly oval, beset with prominent spines. The fresh spores examined in water measure 25 × 20μ. I did not observe their germination: they refused to germinate in water on the several occasions I examined them. There are no paraphyses among the uredospores.

At the same time some bright orange red, more or less waxy looking beds may be seen interspersed among the uredo pustules, which are the *teleutospore beds*. The uredo stage is quickly over, and towards the end of August only teleutospore beds are found. These beds rest on the subepidermal cells. They are formed below the epidermis, which they gradually lift up and disintegrate. In transverse sections through newly formed beds it is seen that they are somewhat elevated above the general epidermis level. Such young beds measure about 30μ in total depth, 18 of which is above the outer surface of the surrounding epidermis. This elevation continues as the bed grows older, until at last its base is on the level of the outer surface of the epidermis.

The *teleutospores* are brilliant orange yellow in colour, and are usually single celled, and somewhat thickened at the free end, and the whole bed is covered externally with a thin hyaline layer (fig. 5, Pl. II). Each spore measures about 13μ in breadth, and 30 to 35μ in length: each usually displays a clear nucleolar space. When a portion of leaf blade containing teleutospore beds is kept in a moist atmosphere the latter are found after some hours covered with minute orange red hairs, just distinguishable with the naked eye. These are the promycelial tubes which each bear a very large oval deeply orange red sporidium, measuring about 27 by 15μ, attached asymetrically to the sterigmata. These sporidia germinate readily in water throwing out a simple germ tube, into which the orange red contents wander. As affected bushes have usually immense numbers of pustules on almost every leaf I thought there might be a perennial mycelium; but an examination of the stem bearing numerous such leaves showed no trace of mycelium.

A very remarkable peculiarity in this fungus is the occurrence of hypertrophies on the leaves and smaller stems, bearing *Puccinia* pustules. It is so extraordinary that one is inclined to believe that it is an accidental association of two parasitic fungi, each perfectly independent; and this view commends itself the more favourably when I note that I never found these *Puccinia* hypertrophies on any other than one particular bush. On this bush, however, I collected many, and a few of them were on leaves bearing immense numbers of *Coleosporium* teleutospores. As the *Puccinia* were so intimately associated with the *Coleosporium* I will note its characters here, leaving the final determination of accidental association, or relationship, to future biological experiment.

I found these *Puccinia* hypertrophies on the 7th August, when the *Coleosporium* is in full growth, on the stem, petiole, and leaf blades. The hypertrophies were studded with black pustules containing *Puccinia* spores. The spores are firmly adherent, and when scraped off appear brownish yellow to the naked eye. By transmitted light they are pale brownish yellow bodies, with thin walls, and very clearly defined nucleolar spaces in each cell. They are clearly, though not deeply, constricted at the septum; sometimes with a slight apical thickening, but oftener not. Externally they are smooth (fig. 7, Pl. II). The fresh spores examined in water measured from 42 to 47μ in total length, and 20 to 24μ in breadth at the septum, which divides the spore into two almost equal halves. The stalks adhering to the scraped off spores are very long, measuring in diameter 5μ at the far end to 10μ at the insertion into the spore. I placed these spores into water with a view to observing their germination: but they do not germinate apparently until after a period of rest.

3. Melampsora Salicis Capreæ, (Pers). ?

On *Salix*, sp.

In April I found this host attacked by a uredo-bearing fungus, but by no means largely. Young shoots were attacked, and in such cases every leaf bore beds. The uredo pustules were extremely numerous on each leaf, and on the lower surface mostly, with only a few on the upper surface. These are round or oval and prominent (hemispherical). The spores are pale yellowish orange, and very deciduous, and each pustule contained club-shaped paraphyses (fig. 8, Pl. I). The spores were very uniform in size and round, measuring 20μ in diameter when examined fresh. The epispore is coarsely tuberculated and the contents granular. I placed these spores in water in a watch glass, but they did not germinate.

After this I lost sight of the fungus until July, when I saw the same host in the same locality much more extensively attacked, probably by the same parasite. Now the leaves were more generally attacked, not as before only leaves on particular shoots. The leaves exhibited patches of discolouration, blackish brown in the centre with a surrounding zone of brownish red, and lastly the whole surrounded by an irregular zone of pale yellow. On the lower surfaces of such patches spore beds were erupted. On the blackish centre there was usually a central pustule, surrounded by a circlet of others ; and beyond this circle, and outside the blackish centre, irregularly disposed small yellow pustules. The spore beds everywhere contained the same uredospores, with very large club-shaped paraphyses surrounding the base, and sparsely also among the spores. A uredo bed may often be seen in the middle of teleutospore beds. The uredospores are not given off in chains but are borne singly on stalks (fig. 8, Pl. I). These spores are oval, and beset sparsely with coarse spines. The fresh spores measure 28 × 22μ, on an average. The heads of the paraphyses are smooth.

Again in September I found the leaves bearing teleutospore fructification. The leaves were now speckled irregularly on their lower surfaces with orange red spots, mostly round but sometimes of an irregular shape from the coalescence of pustules. With a field lens a central cushion of spore beds may be seen, about 2 to 3 m.m. in diameter. On the upper leaf surface these invaded areas are dark red and very conspicuous. Individual leaves are often very extensively attacked. The central spore cushion contains uredospores with extremely large capitate paraphyses. The spores are very pale yellow and echinulate, oval to round, 23μ in diameter to 26 × 21μ. The heads of the paraphyses measured 27μ in breadth by 34μ in length. The teleutospores in mounted specimens, after treatment with alcohol, measure from 34 to 54μ in length and 8μ in breadth.

Remarks.—I have thought it best to name this fungus *M. Salicis Capreae;* but further research may show it to be different.

COLEOSPORIUM, Léveillé.

HEMICOLEOSPORIUM, Schröter.

1. Coleosporium Plectranthi, nov. sp.

On *Plectranthus Gerardianus*, Benth.

This host begins to be attacked towards the end of July, and in August is in the uredo stage. The pustules are entirely hypophyllous, and consist of little yellow heaps of the size of an ordinary pin's head. The pustules sometimes exhibit a circinate tendency. The position of pustules above is indicated on the upper leaf surface by yellow areas, irregular in size and contour. Some leaves have very numerous areas of invasion, whilst others have but very few. The *uredospores* are very pale yellow, oval, densely tuberculated, measuring on an average when fresh and in water 24 × 17μ. The epispore is very thick; but I could not detect any germ pores. They are given off in fairly long chains.

Around these uredo pustules, early in August, some indistinct smears of orange red colour may be seen, the commencing teleutospore beds, and these rapidly acquire prominence. At the end of August teleutospore beds are very numerous: they are strictly hypophyllous on the uredo areas of invasion. The beds are bright orange red waxy looking cushions. A uredo pustule is often, though not always, the centre of a concentric arrangement of teleutospore beds. At the end of August I put some uredospores and some sections of leaf blade through teleutospore beds into water. The former did not germinate, probably because they were too old; but the latter produced a few oval sporidia. I was unfortunately unable to make out the exact morphological form of the promycelium; but as far as I could see it was of the nature of a *Coleosporium* one. The teleutospore beds are covered with a well marked hyaline layer, and the top of each spore often presents a globular mass of the same hyaline substance. The spore cells are usually single but sometimes divided into two or three parts. The whole length of a spore is about 24 to 28μ, and in breadth about 12 – 14μ, (fig. 4, Pl. IV).

2. Coleosporium Clematidis, nov. sp.

On *Clematis montana*, Don.

Clematis Buchananiana, D. C.

A *Coleosporium* on *Clematis montana* is not infrequently found about Simla during August to October: it is not, however, common in the

neighbourhood of the station. Deep orange red waxy looking beds are formed on the under surfaces of the leaves, frequently circinating round a central uredo pustule of much paler and more yellow colour. A single leaf may bear numerous such pustules. On the upper surface the position of these beds below is indicated by irregular patches of paling, not of definite outline or shape.

The *uredospores*, given off in chains, are orange red, densely beset with large tubercles, and measuring when fresh 30 × 20μ on an average; but varying a good deal in individual measurements.

The *teleutospore beds*.—In *Clematis montana* the teleutospores are usually divided into four cells by transverse septa (fig. 3, Pl. IV). The average length of each spore is about 50 to 60μ and 12 to 14μ in breadth. A single sporidium is formed by each cell on a long narrow sterigma (fig. 5, Pl. IV). The spore beds are initially formed beneath the epidermis.

A little later (September) a similar parasite may be found on *C. Buchananiana;* but I am not certain that it is of the same species. In the absence of biological data it may be regarded provisionally as the same. The circinate arrangement of teleutospore beds around central uredo pustules is not observed on this host. The uredo pustules are saffron yellow, and scattered irregularly over the lower surface of the leaf.

The *uredospores*, here also given off in chains, are pale yellow, tuberculated, and measure when fresh 27 × 22μ.

The *teleutospore beds* are brick red, and occur here and there amongst the uredo pustules, which are at the time I got specimens (September), much more numerous, the reverse being the case in the former host. These beds form, as above, elevated cushions on the surface, above the level of the epidermis. In transverse sections the free surface is seen to be covered with a thin hyaline layer, about 25μ in depth. In such sections the palisade layer of cells on the opposite side are seen to be undisturbed. The whole depth of the teleutospore beds in fresh sections examined in water was found to be about 0·189 m.m. Each teleutospore in this host is larger than on the former, measuring about 80 to 100μ in length by 14μ in breadth. Moreover the spores on this host are usually not divided, but sometimes into 2 or 3 parts.

3. Coleosporium Campanulae, Pers.

On *Campanula colorata*, Wall.

Even as early as the 6th February (1889), a few days after the snow had melted, I found this host bearing brilliant orange red uredospore pustules. At this time only the young lowermost leaves and their

petioles were thus attacked, the pustules breaking out from both surfaces of the leaf blade. At this time I found that the uredospores germinated freely in water, throwing out a simple long tube (about 200μ in length, and 5μ in diameter), into which the coloured contents of the spore wandered, leaving the walls of the latter colourless. In March this stage is still common, but now the sori are more frequently erupted from the lower surface of the blade, a few pustules occurring on the upper surface, exactly opposite some below. Still only the lower leaves near the ground are attacked. The sori on the lower surface tend to coalesce now. Towards the end of March the uredospores do not germinate so readily in water. The fungus is then missed to general observation until early in July, when a new crop of uredo pustules attracts attention. These are numerously erupted from the upper leaf surface, and now from the upper leaves on the stalks. At the same time such attacked plants usually exhibit some generally paled lower leaves, on the lower surfaces of which waxy orange red elevations may be seen, which are teleutospore beds. The same leaves usually bear a few uredo pustules as well. This stage continues throughout August; but the teleutospore beds increase in numbers whilst the uredo pustules diminish and become very scarce, though never entirely absent. At the end of September a third crop of uredo pustules is produced, now all over the green parts of the plant, ascending to, and involving even the green parts of the flower and young fruit capsules. Shortly after this the host withers and dries up. From July onwards the teleutospore beds are constantly met with.

The *uredospores* of all three crops are alike, both in measurement and in general appearance (fig. 10, Pl. IV). They are given off in chains, are orange red, thick walled, beset with tubercles, and measure on an average 21 × 17μ; but after lying in water for 12 to 24 hours 25 × 18μ. Each spore appears to have three germ pores.

The *teleutospores* are covered by a well marked hyaline layer. The spores are orange red and are divided by transverse septa into 3 to 5 cells (fig. 2, Pl. IV). The average length of each complete spore is 40 to 45μ, and the average breadth 14μ.

Remarks.—I have named this species provisionally *C. Campanulae;* but it should be noted that both the uredo- and teleutospores are smaller in the Simla species; neither are the uredospores so variable in size and shape as they appear to be in the European species.

GYMNOSPORANGIUM, Hedwig f.

1. Gymnosporangium Cunninghamianum, Barclay.

On *Cupressus torulosa*, Don.

And *Pyrus Pashia*, Ham.

For a detailed description of this, the only species of *Gymnosporangium* in this region, I must refer the reader to a paper on its life history in the "Scientific Memoirs by Medical Officers of the Army of India," Part V, 1889.

The aecidial stage I have already described in a former volume of this Journal* under the name *G. clavariaeforme*, as at that time its characters appeared to me to agree most nearly with those of that European species. Since the discovery of its complete life history, however, I have no doubt that it is a distinct species, and I have renamed it as above.

The teleutosporic stage on *Cupressus torulosa* may be described as follows. The teleutospore beds are hemispherical dark brown compact bodies during dry weather, and are formed on the ultimate small branches as well as on twigs of 4 to 5 m.m. in diameter. During moist weather these beds swell up enormously into gelatinous masses, which quickly assume a yellow ochre colour, due to a rapid formation of sporidia. During heavy rain the gelatinous spore masses fall to the ground.

The *teleutospores* are slender spindle shaped yellow bodies on long stalks covered with a substance capable of swelling greatly when moistened. When the spore becomes detached from the stalk after moistening a characteristic disc remains at the place of junction. There is no appreciable constriction at the septum, and the walls are usually uniformly thick, with sometimes a slight thickening at the apex. The spores when scraped off dry beds and examined immediately in water measure $75{\cdot}6 \times 25{\cdot}2\mu$. Each cell of the spore has two germ pores near the septum. They germinate very readily in water: a promycelium is formed by each cell, dividing into four parts, each forming a sporidium on stout sterigmata. The sporidia are orange red, oval, measuring from 15×9 to $22 \times 14\mu$. The formation of secondary sporidia is not uncommon. Experimental evidence fully confirmed the genetic relationship between these teleutospores and the aecidial form on *Pyrus Pashia*.

* J. A. S. B., Vol. LVI, Pt. II, No. 3, 1887.

CHRYSOMYXA, Unger.

LEPTOCHRYSOMYXA, Schröter.

1. Chrysomyxa Himalense, Barclay.

On *Rhododendron arboreum*, Sm.

A detailed description of this fungus will be found in the "Scientific Memoirs by Medical Officers of the Army of India," Part V. It is an extremely conspicuous parasite, since it gives rise to witches' brooms on the host, and is very abundant. The fructification of the fungus may be seen from early spring to the end of May. This has its seat especially on the petioles and along the midribs a short distance into the leaf blade. When ripe the fruit bodies, which are orange red, clothe the petioles so densely as to hide it completely. Each separate fruit body is club-shaped. The expanded upper part measures on an average 2 m.m. in diameter, and the whole about 1·5 m.m. in length. These fruit bodies are also occasionally found on the main axis of shoots and as isolated groups on the leaf blade. In a moist atmosphere they become pure yellow from rapid sporidial formation. These fruit bodies are found only on the leaves and stems of the previous year's growth; never on the newest. The shoots attacked are dwarfed in growth, and bear smaller leaves than normal. There are no uredospores.

Localised attack of the leaf blade is not common. When it occurs, always on leaves of the previous year's growth, small patches are formed reddish brown above with a cluster of about 25 fruit bodies on the lower surface. The leaf blade at such places is very slightly thickened.

The mycelium in the stem is perennial. It is of the usual characters, contains an abundance of orange red oil globules and forms haustoria.

The fruit body consists of four parts: (*a*), the primary lowermost stalk cells, forming the stalk of the club-shaped fructification: (*b*), a group of large central cells, three to four in each row, usually forking, and forming the main part of the expanded club end of the fruit body: (*c*), secondary stalk cells, branches of the last, which give rise to promycelia: and (*d*), the promycelia proper, measuring about 50μ in length by 10μ in breadth, and dividing into four cells, each of which produces a sporidium at the end of a narrow sterigma. The sporidia are round or oval, orange red, and measure from 9μ in diam. to 12 × 10μ. The sporidia are thrown off forcibly as in the case of *C. Rhododendri* (D. C.).

2. Chrysomyxa Piceae, nov. sp.

On *Picea Morinda*, Link.

I first found this parasite in June at Narkanda (40 miles from Simla) where it is fairly, though by no means very, abundant; but I have since found it fairly common much nearer, namely, at Mashobra, a suburb of Simla. In Simla itself I have never met with it on the comparatively few individuals of the host which are present. At Mashobra I found numerous trees attacked with it in the middle of May, and some very extensively. The upper sides of the needles bore brilliant orange red convex beds, round or oval to oblong. Each needle usually bore several such beds; but varying from 2 or 3 to 16, mostly in a single row. Sometimes, however, there was an imperfect parallel row on the other side of the upper needle surface. I observed that in most trees almost all the beds were on one particular side of the needles, so that they could be much better seen from one side of the tree than from the other. This was probably due to some light effect?

Thus the usual site of eruption is the upper half of the needle surface; but sometimes beds are extruded from the lower side also. In the immediate vicinity of the beds the needles were very slightly paled or yellowed, but very inconspicuously. These fruit bodies occur mostly on the older needles, and by far the most frequently on two-year old needles, and were never present on the youngest just evolved needles. I never found any on the axis. The beds varied from about 0·6 m.m. in diameter to 2·5 or 3 m.m. in length by 0·6 m.m. in breadth. In depth (*i. e.* from the free end to the base on the subhypodermal tissue they usually measured 0·44 m.m.).

The mycelium ramifies among the chlorophyll containing cells between the hypoderma and the endothelial sheath, but appears never to penetrate within the latter. The hyphae are on the whole sparingly distributed, except at the bases of fruit bodies where they are very abundant. They are easily seen in fresh sections as they contain orange red oil globules, and measure 4μ in diameter. The resin canals never contain hyphae; but these are sometimes seen in the air spaces below stomata.

The *fruit body* consists mainly of radiating long oval cells, borne by much septated filaments forming a pseudo-parenchyma. These long cells measure from 0·100 to 0·157 m.m. by 12 to 16μ broad. They may frequently be seen to contain a central well marked nucleus, staining deeply with carmine. These cells are never forked (fig. 1, Pl. IV.) There are a few scattered cells beyond the outer ends of the long cells, on the surface of the fruit body, but they do not appear to

be portions of a promycelium. Unfortunately I have never been able to see any sporidial formation. I have kept needles bearing the fructification in a moist atmosphere, but without seeing any germination. My description of this parasite is therefore very imperfect.

Remarks.—In comparing this fungus with Rees's description of *Chrysomyxa Abietis*, Ung, there appear to be considerable differences, and especially in the large cells forming the main elements of the fruit body. I have examined numerous sections, but have never seen these cells septated, nor forked. It would therefore almost seem that the parasite is more nearly related to *Coleosporium* than to *Chrysomyxa*. The want of observation of the nature of germination unfortunately precludes any decision on this point, and I have included it among *Chrysomyxata* on general rather than on particular analogy. Should future research show that it is in fact a *Chrysomyxa* it would be an interesting example of the very close morphological relationship between this genus and *Coleosporium*.

Among other points of difference may be noticed the larger size of the teleutospore beds in the European species, the smaller number of them on each needle (one to two), their eruption from the *under* surface of the needle, the conspicuous yellow bands of discolouration produced on the needles, the smaller number of teleutospore cells on each fruit body (about 12 against 20 in Simla), and the presence of haustoria.

CAEOMA, Link.

1. Caeoma Smilacis, Barclay.

On *Smilax aspera*, L.

For a detailed description of this parasite I must refer the reader to a paper on its life history in the "Scientific Memoirs by Medical Officers of the Army of India," Part IV. It is apparently a complete autoecious species, but the experimental evidence for this is not complete.*

The *aecidial stage* is found in July on the newly evolved leaves and their petioles. Bright yellow patches are formed on the leaves, more or less irregular in shape, and varying in size from a small point to 2 cm. in diameter. These patches are considerably thickened. When mature such patches bear minute brownish papillae on both surfaces, which are the aecidia. The latter open by a pore, through which the aecidiospores are extruded. These patches also bear spermogonia mostly on the upper leaf surface.

In October, when the aecidial stage is disappearing, the same generation of leaves bear *uredo pustules*, formed by a distinct mycelium.

* Since this paper was read I have completed the evidence.

The lower surfaces of the leaves exhibit a few or a very great many slightly paled circular areas on each of which a minute pustule is formed, containing yellowish brown uredospores. The invaded areas are not in the least thickened. When a leaf is not excessively attacked the uredo pustules frequently exhibit a marked circinate arrangement, two circles around a central pustule.

The *teleutospore stage* consists in the gradual production of *Puccinia* spores in the uredo pustules, which latter then enlarge very greatly. The teleutospore beds are well raised dark brown compact masses. If a leaf bearing teleutospore beds be placed in a moist chamber the beds swell very noticeably, and become light brown in colour. This swelling is due to the swelling of a gelatinous sheath enclosing the stalks of the teleutospores.

The *mycelium* bearing uredo- and teleuto-spores does not contain orange red oil globules, does not form haustoria, and does not give rise to any hypertrophy of the host's tissues. That bearing aecidia contains conspicuous coloured oil globules and gives rise to considerable hypertrophy of the host's tissues; but still does not form haustoria.

The *uredospores* are oval or pyriform, pale yellow, and beset externally with very prominent spines. Among them are a few club-shaped paraphyses. They are formed singly on short stalks. The fresh spores measure on an average 46·5 × 31·7μ. The epispore is thickened at the free end. They do not germinate readily in water, and I have consequently not observed their germination with accuracy.

The *teleutospores* are pale yellow, with long stalks surrounded with a gelatinous sheath. The free end is thickened. They vary in length from 74·0 to 50·8μ: the upper cell varies from 38 × 16 to 25 × 15μ, and the lower from 36 × 16 to 25 × 15μ. The spore is slightly constricted at the septum, and measures about 14μ in breadth. They are firmly adherent. The epispore is smooth. When the stalk is swelled in water the thin central axis is clearly defined as in *Gymnosporangium*. The spores germinate by forming two usual promycelia, but instead of forming sporidia on sterigmata, the four cells of each promycelium separate from one another, and apparently represent sporidia. These detached cells measure from 14 × 8 to 18 × 11μ. I never observed these cells germinating. At the time I wrote the paper referred to above I had never witnessed any variation from this mode of germination. At that time all my cultivations were made in hanging drops of water in a confined atmosphere. Recently, however, I caused the teleutospores to germinate in water in a watch glass, in a large moist atmosphere (as recommended by Plowright), and then the usual sporidial formation took place. The sporidia are oval and orange red and measure from 10μ in diameter to 18 × 8μ.

The *aecidium* is deeply placed and is not bounded by any peridium, but by a layer of convoluted hyphae. The aecidiospores are given off successively from basidia, but ripe spores do not remain attached to one another in rows as usual. As each spore ripens it is cast off, and the spore below, which up to this time remained in a rudimentary condition, then grows rapidly, forming another ripe spore, and so on. The spores are pale yellow, mostly oval, with an epispore of variable thickness, thickened at one end, and beset with large coarse spines, which are deciduous. The fresh spores measure 43·2 × 25·6μ on an average, varying from 36 × 28 to 52 × 16μ. The thickness of the epispore is usually about 4μ, and 6 to 10μ at the thickened end. These spores, like the uredospores, do not germinate readily in water.

The *spermogonia* are plentiful, are deeply set, and a tuft of paraphyses protrude through the mouth. They measure 145μ in depth, and 157 in breadth.

2. Caeoma Mori, nov. sp.

On *Morus alba*, L. var. *θ. serrata.*

This fungus is one of those species situated so nearly between two genera that it is somewhat difficult to decide to which it belongs. On the whole I am inclined to regard it as a species of *Caeoma.*

Curiously enough I only once found it, namely, in November, 1885, and although I have frequently searched for it again I have never succeeded in finding it. Owing to this circumstance my notes of it are very imperfect.

The aecidia are hypophyllous. Although there is no regular coherent peridium the outer aecidiospores resemble peridial cells in being colourless and larger than the aecidiospores proper (fig. 6, Pl. IV), which are reddish yellow, round or oval, and measuring when fresh from 14μ in diameter to 20 × 14μ, but on an average 17 × 14μ. The epispore is thick, measuring 2μ. The outer colourless pseudo-peridial cells measured from 19 × 11 to 22 × 12μ.. I did not observe the germination of the aecidiospores.

ISOLATED UREDO FORMS.

Of isolated Uredo forms six are known to me. Among these two are remarkable, namely, those on *Vitis himalayana* and on *Gomphrena globosa*, the former for forming columnar spore masses, and the latter for producing a curious flocculent mycelium on the surface of water when allowed to germinate there in a moist atmosphere.

1. Uredo Eupatoriae, (D. C.) ?

On *Potentilla* (*Kleinicura*, W. and A. ?)

This host may sometimes be found in July extremely attacked by a uredo bearing fungus. Brilliant orange red or yellow pustules may be found in great numbers on the stem, leaves, petioles, bracts, and even fruit. The spores are brilliantly orange red, irregularly round, beset externally with spines or tubercles, measuring on an average 20μ in diameter when fresh. When placed in water they germinate readily, and normally like uredospores.

2. Uredo Bupleuri, nov. sp.

On *Bupleurum falcatum*, L.

In September this may be found attacked. Numerous minute brown circular pustules are borne on the lower leaf surface, with some irregular discolouration on the opposite or upper leaf surface. The host is at this time in full flower. The spores are brown, round, measuring when fresh 20μ in diameter, with an epispore studded with shallow warts, and with three germ pores usually, but sometimes four. When placed in water they germinate readily in the usual manner of uredospores. Though I have examined pustules up to the time the host dies and is withered up I never saw any other form of spore.

3. Uredo Cronartiiformis, nov. sp.

On *Vitis himalayana*, Brand.

This host is very extensively attacked with a peculiar uredo-like affection, suggestive of *Cronartium*, since the spores are aggregated together into small cylindrical columns, with numerous curved paraphyses at the bases of the columns. The whole, column of spores and paraphyses, are borne on minute papillae on the lower leaf surface. The column of spores is about 1 to 2 m.m. in length, and 0·19 to 0·25 m.m. in diameter.

The parasite is first met with towards the end of July, but continues to increase in abundance until the leaves fall off in autumn (October and November). The pustules are exceedingly small, and are distributed in immense numbers all over the lower surface of the leaf blade. The upper surface of the leaf is studded with reddish brown stains, which makes this otherwise inconspicuous fungus remarkable.

When these columnar heaps of spores are scraped off, which may very easily be done with a light touch, and placed in water, they readily break up into their component elements, and the weight of a cover glass

immediately dissociates the spores. Even when a leaf bearing these columns is first hardened in absolute alcohol the columns do not attain any greater coherency.

The individual spores are obovate or club-shaped, and fairly densely covered with spines. They are pale orange yellow, and measure about 30 × 18 to 27 × 18μ when fresh (fig. 9, Pl. IV).

The earliest formed pustules are yellowish in colour, but later, at the end of August, when the fungus is extremely common, the pustules are brown. The leaves are now old and this may be the sole reason, for the spore columns and spores are identical in size and structure, though the latter are also brownish now. Placed in water the spores of both colours germinate similarly, exactly like uredospores, and very readily, even up to the middle of October.

In August, when the parasite is beginning to appear, I tied some leaves bearing yellow pustules to a plant in my garden which was quite healthy, and in September many of its leaves were studded with similar yellow pustules.

Although I looked carefully and continuously for some teleutosporic form I never found any trace of such.

4. Uredo Apludae, nov. sp.

On *Apluda aristata*, L.

This grass harbours a uredo bearing fungus towards the end of September, but I have never found any teleutospores on it. The uredo pustules are brown, small, oval to linear, very inconspicuous in that it gives rise to no appreciable discolouration in the blade, and entirely hypophyllous. The spores are round to oval, pale brown, thick walled, and measure when fresh 22 × 20μ on an average. Some few are much larger, *viz.*, about 30 × 21μ. The epispore is densely beset with minute tubercles, and has four germ pores. At the end of October I found the same pustules even on drying leaves.

5. Uredo Gomphrenatis, nov. sp.

On *Gomphrena globosa*, L.

Late in October this host is largely attacked in certain localities only. In such places the lower surfaces of the leaves are often densely besprinkled with dark brown, minute, circular pustules, whilst only exceptionally are some found on the upper leaf surface. The upper surfaces of attacked leaves are very slightly paled opposite spore beds on the other side. Spore beds are also formed on the stems and are here linear or oval. The spores are very deciduous, and there are no para-

physes. The uredospores are spiny and yellowish brown, and fall off without any portion of the stalk adhering, although the place of attachment to the stalk is generally very noticeable (fig. 8, Pl. IV). The walls are generally uniformly thick, but in some cases with a very slight apical thickening. The fresh spores examined in water measure on an average 35 × 26·2μ, varying from 32 × 27 to 40 × 24μ. Each spore has two germ spores. When placed in water these spores germinate at once most freely, forming immensely long germ tubes, so long that if numerous spores are floated on water in a watch glass in 24 hours a white silky mould appears to have been formed by them. In germination they are typical uredospores. I never found any teleutospores though I looked carefully for them until the host withered in winter.

6. Uredo Deutziae, nov. sp.

On *Deutzia corymbosa*, Br.

I found this host attacked with a Uredo-bearing fungus in June. The pustules are very pale yellow, hypophyllous, on paled circular areas of the leaf. They are numerous on each leaf. Each pustule, of which there are many on each discoloured patch, is minute and hemispherical. The upper leaf surface is paled opposite the spores below. In general appearance they resemble the Uredo pustules of *Melampsora* or *Coleosporium*. The spores are pale orange yellow, sparsely spiny, round to oval, and measuring 25 − 22 × 21 − 18μ, after lying 24 hours in water.

Remarks.—I found fungus while this paper was passing through the press and I have been unable therefore to illustrate it in the plates. I have not had an opportunity for observing its further development, and must class it meanwhile with isolated Uredo forms. It may possibly be *U. Hydrangeae*, Berk. et Curtis.

ADDENDA.

In the first portion of this list of Uredines* containing a description of the Aecidial forms I noted that I would defer a description of the two forms occurring on *Pinus longifolia* and *P. excelsa*, as my notes of them were at that time incomplete. Descriptions of them now follow. In addition to these I have noted the characters of other two isolated Aecidia.

Since the publication of the second part of this list,† dealing with

* Journal of the Asiatic Society of Bengal, Vol. LVI, Pt. II, No. 3, 1887.

† *Ibid*, Vol. LVIII, Pt. II, No. 2, 1889.

the *Puccinia*, I have discovered six other species, all on the higher *Phanerogamia*, most of them apparently new.

1. Aecidium complanatum, nov. sp.

On *Pinus longifolia*, Roxb.

This *Aecidium*, on the needles of *Pinus longifolia*, is extremely common in Simla, and, indeed, it is rare to find the host free from it. I have once only seen it on the stem (var. *corticola*) and my further remarks refer only to the variety on the needles. The *Aecidium* may be found from autumn to June. A minor crop of aecidia is produced in November on the needles developed in spring, and although numerous in certain localities is not by any means so abundant in general as a second crop which commences in February and which gradually reaches a maximum development in May. The crop commencing in autumn is associated with well marked spermogonia, while that commencing in February is apparently without them.

The needles of the host are annual in this region falling from May to June, that is just before the rains set in. At this time the new needles are emerging from their brown scaly covering, and are about 2 to 3 inches long, and, growing rapidly, entirely replace the needles of the year before in July. (I should here mention that a minor evolution of young shoots and needles occurs in autumn, about November). These newly developed needles bear no sign of attack until the middle of August, when many of them, in favoured localities, may be seen bearing paled areas with spermogonia, which long precede the eruption of peridia. After May the dying needles still adherent may still of course be seen bearing peridia; but these are old, and are either empty or contain only a remnant of aecidiospores. In July, when all the old needles have fallen, there is no vestige of the parasite left.

The *aecidia* are large, flat, prominent bodies, reddish yellow in colour, and borne on paled portions of the needles. Each needle bears from 1 to 8 peridia, mostly on the lower or lateral surface. Their length coincides with the long axis of the needle and is very various. The peridia are usually about 1/5th inch (5 m.m.) in length, but are sometimes as much as 1/2th an inch (12·7 m.m.) in length, and in height from the surface of the needle 1/10th inch (2·5 m.m.).

The *mycelium* is confined to the paled areas of the needle, and does not enter within the endothelial sheath. The hyphae ramify extensively among the parenchymatous cells between the endothelial sheath and the hypodermal cells. They do not appear to do any injury to these parenchymatous cells. There are no haustoria.

The *peridium* is very resistant, and when emptied of the orange red aecidiospores is white. It ruptures along the summit or ridge when ripe to allow the exceedingly numerous aecidiospores to fall out. It consists mainly of two layers of cells (in some parts of three) very firmly adherent to one another, by the interlocking of the prominent spines which cover them externally. The walls of these peridial cells are 4μ thick, and the cells themselves measure when moistened from 28 × 20 to 44 × 29μ, or on an average 38 × 41μ.

The *aecidiospores* are formed in very long rows, those towards the basidia being separated from one another by clearly defined intercalary lamellae. They are oval orange red bodies, with thick epispores, beset with numerous and prominent spines, which doubtless aid in their aerial distribution. The dry spores measure on an average 24·3 × 17·9μ, and when moistened 25·4 × 17·9μ. After lying 24 hours in water they measured 26·4 × 19·6μ on an average. I never succeeded in getting these spores to germinate in cultivations, although I have tried various fluids.

Spermogonia. These are of the usual structure; but are very large and deeply set.

Remarks.—This species must, I think, be considered different from *Aec. Pini* (Willd) Pers., as the aecidia are very different in shape and size. Whilst the species I have described has large *flat* peridia, from 5 m.m. to 1 c.m. in length and 2·5 to 3·5 m.m. in height, those of *A. Pini* are conical or cylindrical and 2 to 2·5 m.m. in height. Moreover, whilst the aecidiospores of the latter are 30 to 34 × 20 to 22μ those of the Simla species are 26—24 × 19—17μ.

2. Aecidium brevius, nov. sp.

On *Pinus excelsa*, Wall.

This is an almost equally abundant *Aecidium*, though less prominent than the above, the peridia being much smaller. It is, I believe, a distinct species. I have only met with it on the needles and never on the stem. It is markedly later in appearing to observation than the former. The aecidia begin to appear early in April, and increase in numbers to June. The needles of this host are not altogether annual, though a great many are shed annually, and those attacked by the parasite are apparently always so shed, as after July no vestige of the aecidia remains. New needles begin to emerge from their scaly coverings towards the end of April, and are full grown in July to August. These new needles are never found attacked.

The *aecidia* are like those of the above species, elongated, flattened, orange red bodies, but much smaller (fig. 2, Pl. III). One of ordinary

size measures $\frac{1}{15}$th inch in length and $\frac{1}{20}$th. to $\frac{1}{30}$th inch in depth. The number of these borne on one needle is usually about four; but varies from one to six, and in exceptional instances even more may be found.

The *mycelium* is confined to the paled portions of the needles and is therefore strictly localised as in the above species. The hyphae ramify among the parenchyma cells between the hypoderma and the endothelial sheath, and does not penetrate within the latter. There are no haustoria.

The *peridium* is very tough and white, consisting of two layers of cells firmly adherent to one another, as in the case of the above species; but the peridial cells are much larger, measuring about 40 × 22μ or 42 × 21μ (figs. 6, 7, Pl. III). This difference is so great as to justify me, I think, in regarding it as a distinct species.

The *aecidiospores* are oval and orange red, with a stout epispore beset with prominent spines. The epispore is often thickened more on one side than on the other (fig. 2, Pl. III). They are formed in long serial rows, and in great numbers within each peridium. Between the lower ones intercalary lamellae are present. The dry spores measure on an average 27·5 × 16·9μ and when moistened, 27·3 × 19·3μ. After lying 24 hours in water they measure 30·2 × 21·2μ on an average. I have failed to observe the germination of these spores also in cultivations, although I have tried them in various media.

Spermogonia. These are of the usual structure; but are very large and deeply set.

Remarks.—I think the differences between these two *Aecidia* are sufficient to warrant their separation as two distinct species. With a view to ascertaining the exact difference in the size of the aecidospores and the peridial cells of the two species I simultaneously treated both in the same way, and then carefully measured them. The needles bearing aecidia were first placed in a mixture of equal parts of glycerine and alcohol and then examined in pure glycerine. The aecidiospores from *P. longifolia* measured on an average of several individual measurements 22·3 × 15μ, whilst those from *P. excelsa* measured 28·6 × 18·4μ. The differences between the aecidiospores and the peridial cells are shown in the following table:

Host.	Aecidiospores.				Peridial cells.	
	Moistened in water.	Dry.	24 hours in water.	Alcohol and glycerine.	Alcohol and glycerine.	Water.
P. excelsa ...	27·3 × 19·3	27·5 × 16·9	30·2 × 21·2	28·6 × 18·4	40 × 22	129·5 × 91·5
P. longifolia	25·4 × 17·9	24·3 × 17·9	26·4 × 19·6	22·3 × 15·0	27·6 × 17·2	38·0 × 41·3

Cooke, considered both species identical (see *Indian Forester*, Vol. III, 1877-78) and named it *Peridermium orientale*, C. but as I think there is no doubt whatever they are quite distinct I have re-named both species.

In a paper describing a *Chrysomyxa* (*C. Himalense*) which is exceedingly common in Simla on *Rhododendron arboreum*, Sm., I have drawn attention to a possible connection between the *Aecidium* on *P. excelsa* and this *Chrysomyxa*,* and have given reasons why a connection with the *Aecidium* on *P. longifolia* is not probable. The occurrence of a double crop of aecidia on *P. longifolia*, of which I did not know when I wrote the paper referred to above, renders it, however, still more difficult to conjecture the life history of this parasite.

N. B.—In order to complete this list I would here draw attention to three other *Aecidia* on other species of the *Coniferae*, namely, two distinct species on the needles of *Picea Morinda* and one on the Deodar. These I had already fully described in this Journal before I commenced a systematic review of all the *Uredineae* of this region. For one of those on *Picea Morinda* (*Abies Smithiana*) described in Vol. LV, Pt. II, No. 1, 1886, I propose to retain the name

3. Aecidium Thomsoni, Berkeley.

although there is some doubt as to the identity of that species with the species in this region; and for the other, described in the same volume, Pt. 2, No. 2, I propose the name

4. Aecidium Piceae, nov. sp.

The species I have described on the Deodar, Volume LV, Pt. II, No. 2, 1886, I now propose naming

5. Aec. Cedri, nov. sp.

6. Aecidium Plectranthi, nov. sp.

On *Plectranthus Coetsa*, Ham.

An inconspicuous and rare *Aecidium* was found first on the 4th July, and then shortly afterwards on a very few bushes in the same locality. The aecidial patches are small, and a single leaf sometimes contained several of them; but usually only one or two. On the upper surface of patches spermogonia could be seen with a field lens, while the under surface bore the peridia. These are short cups open stellately,

* Scientific Memoirs by Medical Officers of the Army of India, Part V, 1889.

and discover brilliant orange red spores. The aecidio-spores are round or oval, beset densely with shallow tubercles or warts, and measure when fresh 25μ in diameter to 26 × 24μ.

7. Aecidium infrequens, nov. sp.

On *Geranium* (*nipalensis*, Sweet ?)

This is also a very rare *Aecidium*. I have only once found it in July, 1886. The aecidial patches in the only specimen I ever saw were very numerous on the leaves, each division of the five lobed leaf bearing from one to six patches. The patches were about $\frac{8}{30}$ inch in diameter. The peridia were entirely hypophyllous, and burst stellately, showing orange red aecidiospores within. The under surfaces of the leaf patches were yellow, and the upper surfaces greenish yellow. After the aecidiospores have fallen out of the peridia the latter become deep brown, and then look like teleutospore beds.

The aecidiospores are round, or angular when dry, of a pale yellowish colour, and with very thin walls. The spores become detached in rows of three or more. The fresh spores varied in size from 14μ in diameter to 18 × 16μ.

The peridial cells are thickened on one side: when seen flat they are angular in contour, and measure about 20μ in diameter.

a. HEMIPUCCINIA.

1. Puccinia Iridis, (D. C.)

On *Iris florentina*, L.

Or *Iris pallida*, Lam.

This host is very frequently attacked by a uredo bearing fungus, and I have found it abundantly both in spring (March) and in autumn (September, November). The pustules, which are borne on both surfaces of the leaves equally, are linear and brown, flanked by the rent edges of the epidermis. The spores are round or oval, deep brown, deciduous, falling off without any portion of stalk adhering, and measuring when fresh from 26μ in diameter to 30 × 24 or 34 × 20μ. The epispore is spiny or tuberculated. They germinate freely in water after the manner of uredospores. The end of the long germ tube sometimes swells into a head, not, however, separated by a septum (fig. 7, Pl. IV). The spores, whether collected in spring or late autumn from dried leaves, always germinated in the same way. Each spore has three germ pores.

I found the *teleutospores* for the first time at the end of 1889, although I had looked carefully for them in previous years, and then in one locality only. They are therefore rare notwithstanding the

abundant distribution of the uredo form. The dried leaves are covered with black pustules, round to oval, on both sides of the leaf, mostly remaining covered with epidermis, and with the spores firmly adherent. The pustules contained a few uredospores also. The teleutospores are small, much constricted at the septum usually, though the spores vary much in shape, and much thickened at the apex. The fresh spores measured 36 to 44μ in total length, by 14 to 18 in greatest breadth, or 10 to 13 at the septum. The thickening at the apex is 6 to 9μ. The spores did not germinate on being put into water, and I therefore conclude that they require a winter rest.

2. Puccinia argentata, Schulz. ?

On *Impatiens amphorata*, Edgw.

In the middle of September I found this host attacked with a brown uredo bearing fungus ; but only in certain localities, and I would characterise it as rare. The upper surfaces of attacked leaves display circular paled patches, and the lower surfaces of these patches bear minute circular brown pustules. Later when the leaf is beginning to wither the invaded areas are conspicuous by their green colour against the yellowed general leaf surface, showing again a lichenoid symbiosis between the chlorophyll cells of the leaf blade and the mycelium of the fungus. A single leaf usually bore immense numbers of these, while the petioles also bore some. Towards the end of September, when the host is beginning to disappear for the season, *Puccinia* pustules are developed, though uredo pustules are still more numerous ; but gradually the uredo pustules recede.

The *uredospores* are brown oval bodies, spiny on the surface, and often displaying a nucleus or nucleolar space, and thus resembling a *Uromyces* spore (fig. 11, Pl. I). They are very deciduous, falling off without any portion of stalk adhering, though the place of union with the stalk is usually clearly definable. The fresh spores measured 24 × 16μ on an average. These spores germinated readily in water, throwing out a long simple germ tube, the end being often curiously twisted into an intricate loose knot. Some smaller germ tubes produced a swelling at the end, but this was not separated off by any septum.

The *teleutospores* are plump rounded spores, irregular in size and shape, and with little or no constriction at the septum. Most of them display a small conical colourless thickening at the free end ; but some are without this (fig. 11, Pl. I). The spores are readily detached from their beds, and little or no portion of the stalk adheres. They are deep brown in colour, and the external surface is very faintly tuberculated over both cells. An averaged sized spore measured when fresh 32μ in

total length, and 18μ at the septum, which divides the spore into equal parts: a nucleus is contained in each cell. The spores do not germinate immediately after ripening.

3. Puccinia nitida, nov. sp.

On *Polygonum amplexicaule*, Don.

I have never found this fungus actually in Simla; but it is fairly common at Mashobra, a suburb about 6 miles from the station. In one locality many plants were abundantly attacked. Leaves usually bore innumerable pustules, some brown and some black, mostly hypophyllous, rarely epiphyllous. The former are uredo and the latter teleutospore pustules.

The *uredospores* are round to oval, light brown, spiny, and 22 × 24μ in diameter when fresh (fig. 10, Pl. I).

The *teleutospores* are plump, rounded, deep brown, and very slightly constricted at the septum. Each cell has a well marked nucleolar space, and the free end is not thickened (fig. 10, Pl. I). The germ pore of the upper cell is clearly visible a little to one side of the summit. The spores are readily detached, with usually no portion of stalk adhering. The epispore over both cells is finely tuberculated. The spores are very variable in size and shape: some of the smaller squatter spores measure 26μ in total length, by 16μ at the septum, and 19μ in greatest breadth. Larger spores measured 38 to 44μ in length, by 18μ at the septum. The spores do not germinate immediately after ripening.

Remarks.—Saccardo notes three species of *Puccinia* on species of *Polygonum*, namely, *P. Polygoni*, Pers, *P. Bistortae*, Strauss, and *P. mammillata*, Schröter. I do not think the Simla species is identical with any of them. At any rate it is not *P. Polygoni*, *Alb et Schwein*, because the uredo sori in Simla are not irregular and not circinate; the teleutospores are not adherent, no portion of stalk remaining on the detached spores; they do not contract towards the stalk; and are not thickened at the apex.

4. Puccinia Fagopyri, nov. sp.

On *Fagopyrum esculentum*, Moench.

At the beginning of October I found some stray plants of this host growing on a weedy bank far from cultivated fields, largely attacked with a fungus bearing black and dark brown teleutospore and uredo pustules, all hypophyllous, with circular paled areas on the upper leaf surface.

The *uredospores* are pale brown echinulate bodies, oval and measuring 23 × 18μ on an average. The spores germinated in water in the usual way (fig. 9, Pl. I). I have occasionally seen a globular expansion at the end of the germ tube, as shown in the figure; but this is never separated off by a septum.

The *teleutospores* are very deciduous, falling off with only a fragment of stalk adhering. They are dark brown and very variable in size and shape, somewhat constricted at the septum, with a smooth surface, and slightly thickened at the apex. A clear nucleolar space is seen in each cell (fig. 9, Pl. I). The fresh spores measured from 25 to 36μ in total length, by 11 to 13μ at the septum. The septum divides the spore into two almost equal halves. The upper cell is often much broader than the lower, and is more or less globular. The apical thickening is about 4μ in depth, the cell wall elsewhere being about 2μ in thickness. The spores do not germinate immediately after ripening.

5. Puccinia Gentianae, (Strauss).

On *Gentiana Kurroo*, Royle.

I found two plants of this host at the end of December largely attacked with a *Puccinia*, on a hill some miles from Simla to the south (near Solon); but have never seen it again. The plants I found were withered. The under surfaces of the leaves bore numerous black circular isolated pustules. On examining the spores from these they were found to consist of teleutospores with a few uredospores. The spores are readily detached from their beds, coming off with a fragment of stalk usually adhering.

The *uredospores* are oval, pale brown bodies, spiny, measuring 26 × 22μ after lying 24 hours in water.

The *teleutospores* are plump and rounded at both ends, and slightly if at all constricted at the septum. The epispore is very finely tuberculated over both cells, and is uniformly thick, with the exception of a very shallow mamillated thickening at the free end. Each cell of the spore exhibits a clear nucleolar space or body. After lying 24 hours in water these spores measured from 38 to 40μ in length by 25 to 26 in breadth. They are very uniform in size. They do not germinate immediately after ripening. Occasionally a single celled teleutospore may be seen.

Remarks.—This is most probably *P. Gentianae* (Strauss) as the characters of both uredo and teleutospore agree; but I have not seen any *Aecidium*. The locality, however, in which I found the fungus is not familiar to me: I have only once visited it in winter.

b. MICROPUCCINIA, Schröter.

6. PUCCINIA LEPTODERMIS, nov. sp.

On *Leptodermis lanceolata*, Wall.

For description see above under *Melampsora Leptodermis*.

7. PUCCINIA WATTIANA, nov. sp.

On *Clematis puberula*, H. f. and T.

This fungus was collected by Dr. George Watt in the Sutlej valley, near Suni, 2,500 ft., in October 1889. The leaves were covered with blackened, more or less circular patches, on the under surfaces of which were numerous dark brown pustules, with a marked circinate arrangement: a few pustules, however, were found also on the upper leaf surface. The blackened areas of discoloration measured 3—4 m.m. in diameter, and each leaf bore numerous such patches, from 5 to 30. Some pustules were also discovered on the petioles and ultimate stems.

The spores are readily detached, coming off with a considerable portion of stalk adhering. They are deep chestnut brown, smooth on the surface, rounded at both ends, with little constriction at the septum, and often presented a small colourless mammilla at the free end, which is not otherwise thickened. Spores were often seen divided into 3 and even 4 cells, and a few were single celled. There were no uredospores. The spores measured, when just moistened $42 - 37 \times 21 - 20\ \mu$.

The spores, which had been preserved *in situ* in ordinary botanical drying paper, were placed in water on the 4th May 1890, and on the following day they were found to have germinated freely. The promycelia are usually quite short, though sometimes long, and are colourless. It is remarkable that whilst the upper promycelium issues from the apex as usual, the lower one is emitted from a point close to the stalk. The sporidia are oval and colourless, measuring $15 - 14 \times 8 - 7\mu$, and are borne on short sterigmata. No secondary sporidia were formed.

Remarks.—Saccardo mentions 2 species of *Puccinia* on species of *Clematis*, *viz.*, *P. stromatica*, Berk. et Curtis, and *P. insidiosa*, Berk. In the absence of measurements it is impossible to determine whether the species I have described is identical with either. The general characters of the spores of *P. insidiosa* are unlike those I have described. The spores of *P. stromatica* are somewhat similar; but the sori are said to be diffuse and ruddy. I am inclined to think that the species I have described is distinct, and I have named it after Dr. G. Watt. I regret being unable to give figures of the spores, as I obtained the specimens after this paper had been sent to press.

N. B.—Since the publication of Part II of this List I have been able to follow the complete life history of the *Puccinia* there described under the name *P. helvetica*, Schröter, and there is no doubt that it is a new species. Aecidial fructification is entirely suppressed. I have given a full description of it under the name *Puccinia Collettiana* in the Scientific Memoirs by Medical Officers of the Army of India, Part V, 1889.

DESCRIPTION OF THE PLATES.

Plate III.

Fig. 1. *Uromyces Vossiae*, uredospore. 2, ditto, teleutospore. 3. *Phragmidium subcorticium*, teleutospore, × 220. 3. a, ditto, aecidiospore. 4. *Phragmidium Rubi*, teleutospore. 5. ditto, germinating, with sporidial formation. 6. ditto, uredospores. 7 *Melampsora Salicis Capreae*, transverse section through teleutospore bed, × 220. 8. ditto, through uredo bed, × 220. 9. *Puccinia Fagopyri*, teleutospore, and germinating uredospore. 10. *Puccinia nitida*, three teleutospores and uredospore. 11. *Puccinia argentata*, two teleutospores and uredospore.

Plate IV.

Fig. 1. *Melampsora Sancti-Johannis*, transverse section through teleutospore bed, × 150. 2. ditto, transverse section though leaf bearing uredo bed and spermogonia, × 220. 3. ditto, natural appearance of wholly involved very young shoot. 4, ditto, surface view of teleutospore bed. 5. *Melampsora Leptodermis*, transverse section though young teleutospore bed, × 220. 6. ditto, though uredo bed, × 220. 7. *Puccinia Leptodermis*.

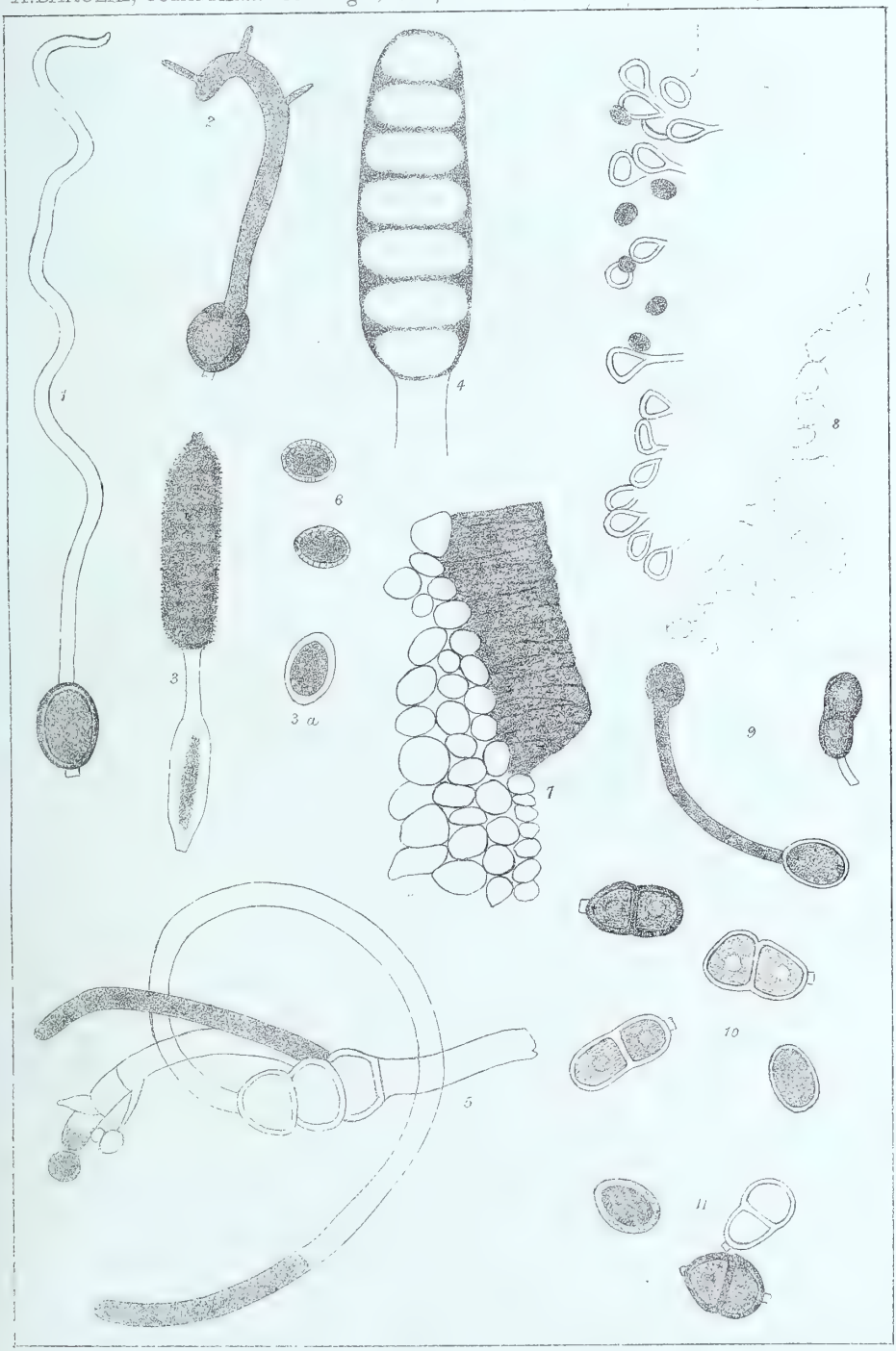
Plate V.

Fig. 1. *Aecidium complanatum*, natural appearance. 2. *Aec. brevius*, natural appearance. 3. *A. complanatum*, transverse section though peridium. 4. ditto, peridial cells seen flat. 5. ditto, lowermost cells of row of aecidiospores, showing intercalary lamellae. 6. *A. brevius*, peridial cells seen flat. 7. ditto, transverse section though peridium. 8. *A. complanatum*, aecidiospores. 9. *Aec. brevius*, aecidiospores.

Plate VI.

Fig. 1. *Chrysomyxa Piceae*, transverse section though fruit body, × 150. 2. *Coleosporium Campanulae*, transverse section though teleutospore bed, × 220. 3. *Coleosporium Clematidis*, transverse section through teleutospore bed on leaf of *C. montana*, × 220. 4. *Coleoporium Plectranthi*, transverse section through teleutospore bed, × 220. 5. *Col. Clematidis*, promycelium with sporidial formation (*C. montana*). 6. *Caeoma Mori*, sterile and fertile aecidospores. 7. *Puccinia Iridis*, germinating uredospore. 8. *Uredo Gomphrenatis*, uredospore. 9. *Uredo cronartiiformis*, uredospore. 10. *Coleosporium Campanulae*, uredospore.

N. B.—Unless otherwise specified all figures are × 350.



A. Barclay, del. Lith: K. D Chandra.